organs like the spleen, can be extirpated without causing essentially different effects from those seen to follow castration. The presence of the reproductive organs, on the other hand, exerts a profound influence on the body. From the standpoint of Kölliker all the organs of the body are morphologically homodynamous while physiologically related as chief and subordinate groups.

In this connection we may briefly refer to another matter which has engaged the attention of morphologists, viz., the question of homologies. It is well known that in the segmented animals the organs of the body are (typically) repeated for each segment so that there is a certain independence in the segments. In many worms a detached segment or segments may reproduce the whole body, and similarly the detached segments are reproduced in the animal from which they were taken. The number of segments also is often indefinite and increases with age. There are animals with the segments alike and others where differentiation has taken place. In all these latter cases, the segments cannot reproduce themselves and their number is fixed. Just as there are cell groups that dissolve to allow each cell to enter upon its reproductive work so there are segmented forms, like the Hydroid *Strobila*, and the Tape-worm in which the segments become separated for reproductive purposes. In the embryology of segmented animals, the segments appear successively as in the *Strobila*. Now if we conclude that metameric segmentation is of the nature of zooid reproduction by division (*strobilisation*) we can easily account for correlated variation, for the egg is the ancestor of a typical first zooid, which is ancestral to all the others, and any hereditary peculiarity of any part of this zooid must appear in all the other segments. If we adopt this view, can we apply the Weismann dictum? Which is the segment that remains undifferentiated and is the equivalent of all the others? Here again, Kölliker has the better of the argument. A study of the growth of *Chara* seems to point to a compromise between the two positions and also serves as a model to show how complicated a structure may be built up by the *repetition of a single mode of division*, of which the law in *Chara*, is: The continuous production, from an apical cell of cells that are each capable of division into two cells, one with the characteristics of the apical cell, the other (the internodal cell) with the powers of indefinite growth without division.

Article "Sex" Enc. Britannica; and Proceedings of the Royal Society of Edinburgh, 1886. GEDDES.

Geddes attempts an explanation of a division of this sort, by considering, that two sets of forces *Katabolic* (those that destroy protoplasm, liberate energy, and effect external work, resulting in cell multiplication) and *Anabolic* (those that build up protoplasm, absorb energy, and effect internal work, or growth) are in a certain balance in life; and there is an alternation between the ascendency of the two sets of forces. An *ovum* is a cell in which anabolism is in the ascendant, and a spermatozoon is one in which katabolism reigns. It is easy to see how the fertilization of the *ovum* leads to its segmentation, on this view. But theories of this nature are only partially explanatory. No theory can be true or even of temporary value, unless it harmonizes with the majority of known facts, and when no one fact is fatal to it.

We have yet to enquire how a division of this sort is determined in exactly the mode needful for the good of the species. Not only do we enquire how are cells divided so as to be different, and what causes this difference, but the great question is how is the response of protoplasm to the action of the environment such as to intelligently adapt the being to the conditions of the environment. When an amœba ascertains from

certain conditions that the pool of water in which it lives is about to dry up, it proceeds to envelop itself in a cyst in which it lies preserved until the next rain. Now we could easily imagine some being *endowed with intelligence* making an automaton that would respond in a similar manner to set conditions. But the amœba can do what no automaton could possibly do. It can adapt itself to new conditions if not too violent a change is made. It can *learn*, it must *experience*, and evolution is its account for the powers already acquired by ancestral experience. Ultimately, in all explanations of heredity, the powers of mind are tacitly conceded and if consciousness and mind in the higher animals are the results of evolution, it must be conceded that mind is present wherever there is protoplasm; and it may well be asked, are not all the properties exhibited by protoplasm (aside from such chemical and physical properties as it possesses in common with all other matter) of such a nature as to require terms borrowed from mental phenomena (*e. g. experience* and *idioplasm*). It is true that the activities of protoplasm are all of a physico-chemical nature and obey the law of the conservation of energy. But the problem of heredity is not primarily concerned with the physiology of protoplasm, but with problems of the origin of species, phylogenetic and ontogenetic questions that are totally foreign to chemical and physical phenomena. It is because of this that the problem of heredity becomes a psychological one, and for this reason psychology and biology are so intimately related; just as soon as phychology becomes a matter of research, rather than speculation, it needs the prefix *physiological*. In this connection consult:

"*La vie psychique des micro-organismes*" in *Études de psychologie experimentale*. Paris, 1888. Also translated by Thomas McCormac. Open Court Publishing Company, Chicago, 1889.

As higher animals are congeries of cells and we may believe that the psychological phenomena of higher organisms are the resultants of the activities of the cells, it behooves us to study the psychology of the unicellular animals. We are wont to think of several cells as needful for a psychic process in man, but here we see all the psychic processes taking place without nerves and ganglia, as responses of protoplasm to the direct action of the environment. Perhaps it would be more proper to say that the protoplasm reacts, where it is useful or needful for it to do so, in *intelligent response* to the conditions of the environment. The environment is always acting upon the cell whether there is a response or not. Protozoa exhibit exquisite sensibility without sensory organs. Pigment spots (*chromatophores*) and lenticular bodies are usually present in forms that manufacture starch from carbon dioxide by means of the energy of the sun's light, so that these "eyes" appear to be nutritive rather than sensory organs, though possibly both. The maximum amount of absorption of the sun's energy corresponds with the bands of the spectrum complementary of the colors of the protoplasm, and at the same time the maximum amount of oxygen is excreted, as proved by the bacterial test. Besides touch, there must be smell or taste for great delicacy of choice of food is often experienced as in those forms that prey on a single species of plant or animal. Some of these (*Didinium nasulum*) throw darts ("trichocytes") at their victims at a distance to paralyze them. Preudopodia and cilia are organs of motion. Some of the latter are automatic and others are under the control of the will. In sexual reproduction or conjugation there is exhibited a certain choice of certain individuals for each other. Then follows a series of evolutions or dancings about that may last for days; there is apparent a conflict between two impulses, one seeking union, the other a desire to escape; yet finally conjugation ensues. The spermatozoa and ova of higher animals are unicellular and unite under similar laws. The gen-